

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
13 May 2004 (13.05.2004)

PCT

(10) International Publication Number  
**WO 2004/039527 A3**

BEST AVAILABLE COPY

- (51) International Patent Classification<sup>7</sup>: **B23K 9/235**,  
15/00, 20/12, C22F 1/04
- (21) International Application Number:  
PCT/GB2003/004646
- (22) International Filing Date: 28 October 2003 (28.10.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
0225518.0 1 November 2002 (01.11.2002) GB
- (71) Applicant (for all designated States except US): **AIRBUS UK LIMITED** [GB/GB]; New Filton House, Filton, Bristol BS99 7AR (GB).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **ILYUSHENKO**,

Rostyslav [UA/GB]; Flat 33, 71 Pembroke Road, Bristol BS8 3DR (GB). **MAZIARZ, Robert, Jan** [GB/GB]; 71 Hill House Road, Downend, Bristol BS16 5RT (GB). **DAVIES, Huw** [GB/GB]; 12 Monks Park, Malmesbury, Wiltshire SN16 9JF (GB).

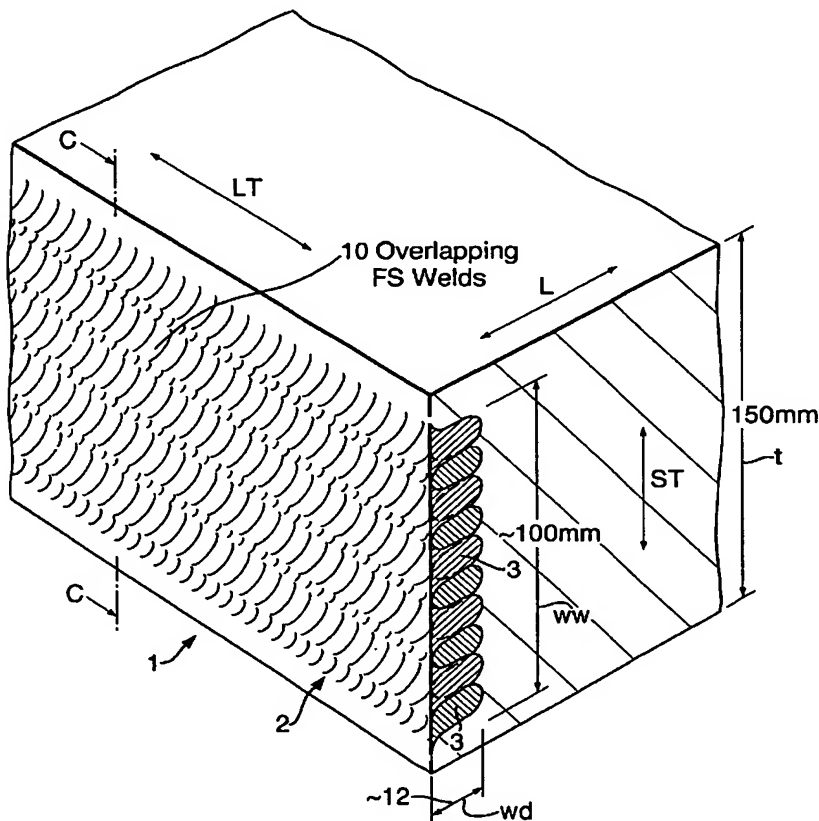
(74) Agents: **PEARSON, James, Ginn et al.**; Abel & Imray, 20 Red Lion Street, London WC1R 4PQ (GB).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),

[Continued on next page]

(54) Title: WELDING METHOD



(57) Abstract: Two aluminium alloy work-pieces are welded together. Firstly, a portion (2) of each work-piece (1) is prepared, the preparation including the performance of a surface treatment, such as friction stir welding, that results in a region (3) extending from the exterior surface into the work-piece having a grain structure that is finer than the grain structure of the work-piece outside that region. Then the work-pieces are welded together by means of a fusion welding process, such as electron beam welding, that joins the respective prepared portions (2) of the two work-pieces (1). The preparation of the work-pieces is so performed that said region (3) extends into the work-piece to a depth that exceeds the depth of material that is caused to melt during the fusion welding process.

WO 2004/039527 A3



Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,  
ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO,  
SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM,  
GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**(88) Date of publication of the international search report:**  
17 June 2004

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**Published:**

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

# INTERNATIONAL SEARCH REPORT

Int. Application No  
PCT/GB 03/04646

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B23K9/235 B23K15/00 B23K20/12 C22F1/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B23K C22F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	"Welding of austenitic steel pipes - is carried out after initial cold plastic working" DERWENT, 5 November 1977 (1977-11-05), XP002237577	1-9, 11, 14
X	abstract	10
X	EP 1 162 283 A (BOEING CO) 12 December 2001 (2001-12-12)	12, 13
Y	column 14, line 10 - line 25; figure 15	1-9, 11, 14
A	JP 2001 234308 A (KAWASAKI HEAVY IND LTD) 31 August 2001 (2001-08-31) abstract	1-12
	-/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents:

\*A\* document defining the general state of the art which is not considered to be of particular relevance

\*E\* earlier document but published on or after the international filing date

\*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

\*O\* document referring to an oral disclosure, use, exhibition or other means

\*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*Z\* document member of the same patent family

Date of the actual completion of the international search

24 March 2004

Date of mailing of the international search report

16/04/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

De Backer, T

# INTERNATIONAL SEARCH REPORT

Int      nal Application No  
PCT/GB 03/04646

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SAITO N ET AL: "GRAIN REFINEMENT OF 1050 ALUMINUM ALLOY BY FRICTION STIR PROCESSING" JOURNAL OF MATERIALS SCIENCE LETTERS, CHAPMAN AND HALL LTD. LONDON, GB, vol. 20, no. 20, 15 October 2001 (2001-10-15), pages 1913-1915, XP001082980 ISSN: 0261-8028 the whole document	1-14
A	JP 2002 249860 A (NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL & TECHNOLOGY) 6 September 2002 (2002-09-06) abstract	1-14
A	US 5 211 910 A (KRAMER LAWRENCE S ET AL) 18 May 1993 (1993-05-18) the whole document	1-14
A	DVORNAK M J ET AL: "THE WELDABILITY AND GRAIN REFINEMENT OF AL-2.2LI-2.7CU" WELDING JOURNAL, AMERICAN WELDING SOCIETY. MIAMI, US, vol. 68, no. 8, 1 August 1989 (1989-08-01), pages 327-S, XP000050376 ISSN: 0043-2296 the whole document	1-14
E	US 2003/218052 A2 (LITWINSKI EDWARD) 27 November 2003 (2003-11-27) the whole document	1,9-11

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 03/04646

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1162283	A	12-12-2001	US 6398883 B1	04-06-2002
			CA 2348113 A1	07-12-2001
			EP 1162283 A2	12-12-2001
			JP 2002104289 A	10-04-2002
JP 2001234308	A	31-08-2001	NONE	
JP 2002249860	A	06-09-2002	NONE	
US 5211910	A	18-05-1993	AU 7243491 A	21-08-1991
			CA 2071555 A1	27-07-1991
			DE 69117494 D1	04-04-1996
			DE 69117494 T2	11-07-1996
			EP 0512056 A1	11-11-1992
			ES 2084154 T3	01-05-1996
			IL 96809 A	29-06-1995
			JP 3197274 B2	13-08-2001
			JP 5503737 T	17-06-1993
			KR 192936 B1	15-06-1999
			NO 922877 A	20-07-1992
			NZ 236886 A	28-04-1993
			PT 96582 A , B	15-10-1991
			WO 9111540 A1	08-08-1991
US 2003218052	A2	27-11-2003	US 2004000576 A1	01-01-2004
			US 2004004107 A1	08-01-2004